CALIFORNIA DEPARTMENT OF TOXIC SUBSTANCES CONTROL
HUMAN AND ECOLOGICAL RISK DIVISION (HERD)

HERD ECOLOGICAL RISK ASSESSMENT NOTE

HERD ERA NOTE NUMBER: 1

ISSUE DATE: MAY 15, 1998

ISSUE: Depth of soil samples used to set exposure point concentration for burrowing mammals and burrow-dwelling birds in an ecological risk assessments.

GUIDANCE: Surface to six feet unless: 1) groundwater is encountered at depths less than six feet; or, 2) elevated soil concentrations occur at depths less than six feet.

SUPPORTING INFORMATION

The surface to two feet has frequently been proposed for ecological risk assessments which include fossorial mammals or burrow-dwelling birds as a representative species. HERD has found evidence in the peer-reviewed scientific literature that fossorial mammals can excavate burrows to depths greater than previously believed. Pocket gopher burrows extend to approximately six feet in the Sacramento Valley (Miller, 1957). Two different burrow depths were demonstrated for Townsend's ground squirrel in southeastern Idaho (Reynolds and Wakkinen, 1987). The deeper burrows extended to depths greater than 120 cm. The majority of California ground squirrel burrows are within 30 to 48 inches of the surface, although the deepest of six California ground squirrel burrows in Davis, California was 80 inches below the surface (Linsdale, 1946). The same publication cites one burrow in Fresno County 28 feet below ground surface in a chalk pit.

The Office of Environmental Health Hazard Assessment (OEHHA) Ecotoxicology Unit furnished the table of terrestrial burrow depth information for California species (Attachment 1). The data do not provide complete coverage of the literature available for any given species, nor does it include all soil burrowing species in California. Rather, the table provides a representative list of different types of burrowing animals and includes some special status species. References cited in Attachment 1 are listed after the table. The burrow depth data were reported in a variety of units, but were converted to inches for the table. In the case of cliff- or bank-nesting birds, vertical burrow depth reported in the table refers to the distance of the (horizontal) burrow from the top of the cliff or bank.

The soil exposure point concentration for ecological receptors should be based on the surface to six-foot depth unless groundwater is encountered at depths less than six feet. The exception to this procedure is that a different soil depth interval should be used in cases where the highest concentrations are found in samples from a specific depth less than 6 feet or groundwater is encountered at depths less than six feet.

EXAMPLES

By way of example, in the cases presented below, the choice of soil depth interval would be different for the three hypothetical sites:

1. The soil depth interval for calculating the exposure point concentration for Site 1 would be surface to 2 feet including the samples take at 2 feet. The soil in the surface to two feet at Site 1 is obviously higher in copper than the soils below two feet. Inclusion of the soil samples below two feet would 'dilute' the soil exposure point concentration with concentration values from unimpacted soils.

2. Soil samples from the entire soil depth interval from the surface to six feet should be used to calculate the soil exposure point concentration for Site 2. Soil DDT concentrations are fairly uniform from the surface to six feet and the exposure point concentration will not be artificially decreased by including unimpacted soils when calculating the exposure point concentration.

3. Soils samples from the surface to three feet, including the samples at three feet, should be used to calculate the exposure point concentration for Site 3. The soil benzo(a)pyrene concentrations are obviously elevated in the two to three foot soil depth interval. However, fossorial mammals cannot access the soils between two and three feet without encountering the soils from the surface to two feet, so the surface to three feet is a reasonable approach to calculating the soil exposure point concentration. A pattern of soil contamination similar to the hypothetical example provided for Site 3 has been observed at some sites in California.

Sample Depth (ft)	Site 1 Soil Copper (mg/kg)	Site 2 Soil DDT (µg/kg)	Site 3 Soil Benzo(a)pyrene (µg/kg)
0.5	430	4510	90
0.5	510	4250	70
1.0	400	4400	80
1.0	580	4700	100
1.5	490	4390	400
1.5	450	2050	450
2.0	550	3500	1010
2.0	600	5020	1090
2.5	110	4800	2030
2.5	120	4740	2200
3.0	80	5100	2870
3.0	50	4900	3090
4.0	45	4270	90
4.0	52	4460	100
5.0	58	5120	80
5.0	45	4790	100
6.0	40	3900	110
6.0	52	4170	90

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Attachment 1. Burrow Depths of Selected Terrestrial California Species

Species	Digs own burrow ?	Uses other species' burrows?	Vertical burrow depth (to nearest inch)	Study location; soil type	Seasonal Use	Note	Reference
Mammals							
broad-footed mole *Scapanus latimanus*	Yes		>12	friable	all	measured during breeding	Zeiner et al. 1990*
desert cottontail *Sylvilagus audubonii*	Yes		6-10	CA	breeding		Ingles, 1941
brush rabbit *Sylvilagus bachmani*	Yes		3-6				Zeiner et al., 1990*
California ground squirrel *Spermophilus beecheyi*	Yes		18-66 (mean 38.1) ≥ 24	CA CA	all breeding		Grinnel and Dixon, 1918 Fitch, 1948
Merriam's kangaroo rat *Dipodomys merriami*	Yes		13	AZ	all		Reynolds, 1960
little pocket mouse *Perognathus longimembris*			20-26	CA			Kenagy, 1973
San Joaquin antelope squirrel *Ammospermophilus nelsoni*	Yes	kangaroo rat	< 39	CA; sandy loam	all		Best et al. 1990*
Fresno kangaroo rat *Dipodomys nitratoides exilis*	Yes		up to 36 (typical 8-10)	CA; sandy loam	all		Culbertson, 1946
striped skunk *Mephitis mephitis*	Yes	Yes	35-47 12-78 (mean 39.4)	MI	winter		Godin, 1982* Allen and Shapton, 1942
badger *Taxidea taxus*	Yes	Yes	up to 91	ID, UT	all		Long and Killingley, 1983; secondary
San Joaquin kit fox	Yes	ground	up to 50 (also	CA	all		Morrell, 1972

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Vulpes macrotis mutica		squirrel, badger, coyote	see ground squirrel)				
Birds							
Alcidae: rhinoceros auklet *Cerorhinca monocerata;* tufted puffin *Fratercula cirrhata*; Cassin's auklet *Ptychorampus aleuticus*	Yes		see note	primarily offshore CA	breeding	cliff nesters (generally burrow from sea level to ca 500 ft)	Baicich and Harrison, 1997*
barn owl *Tyto alba*	Yes	ground squirrel	89.5% of total arroyo height, average	CO; soil of arroyo/river banks	breeding		Millsap and Millsap, 1987
			up to 48	CA		measured from top of bank	P. Bloom, Western Foundation for Vertebrate Zoology, Santa Ana, CA, 1998, pers. comm.
burrowing owl *Athene cunicularia*	Rare	ground squirrel, badger	see ground squirrel	CA	all		Coulombe, 1971; Thomsen, 1971
			18-30	CA		measured during breeding season	J. Gervais, Oregon State University, Corvallis, OR, 1998, pers. comm.
belted kingfisher	Yes		14-25	prefer high	breeding		Hamas, 1994*

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Ceryle alcyon			up to 60 (typical 12-18)	sand, low clay MN; sandy clay		located at the bottom of soil organic layer	Cornwell, 1963
bank swallow *Riparia riparia*	Yes			fine-textured or sandy	breeding	bores tunnel into vertical bank/cliff	Baicich and Harrison, 1997* secondary
northern rough-winged swallow *Stelgidopteryx serripennis*	No	bank swallow			breeding	uses tunnel in banks 2-50 ft high	Baicich and Harrison, 1997*
Reptiles							
garter snake *Thamnophis sirtalis*	No		98	WI	winter		Costanzo, 1985
desert iguana *Dipsosaurus dorsalis*	Yes	Yes	2.5 2-24 2-10 (mean 4.2)	CA sand	all	measured in July measured in winter measured in winter in captive subjects	Norris, 1953 Cowles, 1941 Moberly, 1961
desert tortoise *Gopherus agassizii*	Yes		36 79	UT NV	all	measured in summer measured in winter	Woodbury and Hardy, 1948 Bailey et al., 1995*
blunt-nosed leopard lizard *Gambelia sila*	No	ground squrrel, kangaroo rat	see ground squirrel	CA			Montanucci, 1965*

*Secondary source

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